NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND (No.)

Code 378

* Indicates a North Dakota Supplement

DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 ft or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

SCOPE

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.
3. The effective height of the dam is 35 ft or less, and the dam is hazard class (a).

CONDITIONS WHERE PRACTICE APPLIES

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and ground-water flow will maintain an adequate supply of water in the pond. The quality shall be suitable for the water's intended use.

*** Reservoir area.** The topography and soils of the site shall permit storage of water at a depth and volume that ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

*PLANNING CONSIDERATIONS

* **Design criteria for embankment ponds**

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control.

The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

- **Seepage control.** Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam.

  Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

* **Earth embankment.** The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 ft for one-way traffic and 26 ft for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall meet the requirements of the responsible road authority.

Table 1.- Minimum top width for dams

Total height of embankment	Top width
ft	*ft*
10 or less	6
10 - 15	8
15 - 20	10
20 - 25	12
25 - 35	14
35 or more	15

* The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required.

* If needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (Technical Releases 56 and 69).

The minimum elevation of the top of the settled embankment shall be 1 ft above the water surface in the reservoir with the emergency spillway flowing at design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top of the dam shall be 2 ft for all dams having more than a 20-acre drainage area or more than 20 ft in effective height.

The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

***Principal spillway.** A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

* The crest elevation shall be no less than 0.5 ft below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 ft for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

*The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The diameter of the pipe shall not be less than 4 in. If the pipe conduit diameter is 10 in or greater, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

Pipe conduits under or through the dam shall meet the following requirements. The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For dams 20 ft or less in effective height, accept able pipe materials are cast-iron, steel, corrugated steel or aluminum, asbestos-cement, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Asbestos-cement, concrete, and vitrified clay pipe shall be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight shall

be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 ft in effective height, conduits shall be plastic, reinforced concrete, cast-in-place reinforced concrete, corrugated steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 ft. Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle, if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet. Protective coatings of asbestos-bonded, asphalt coated, or vinyl coating on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5.

Specifications in Tables 2 and 3 are to be followed for polyvinyl chloride (PVC), steel, and aluminum pipe.

* Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Practice standard 430-FF provides criteria for cathodic protection of welded steel pipe.

* Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exist:

1. The effective height of dam is greater than 15 ft.
2. The conduit is of smooth pipe larger than 8 in.
3. The conduit is of corrugated pipe larger than 12 in. in diameter.

Table 2. - Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
in		*ft*
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6,8,10,12	Schedule 40	10
	Schedule 80	15
	SDR 26	10

[1]Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ATSM-D-1785 or ATSM-D-2241.

Table 3. - Minimum gage for corrugated metal pipe [2-2/3-in x ½-in corrugations][1]

Fill height (ft)	Minimum gauge for steel pipe with diameter (in) of ——						Minimum thickness (In) of aluminum pipe with diameter (in) of ——			
	21 and less	24	30	36	42	48	21 and less	24	30	36
1 - 15	16	16	16	14	12	10	0.06	0.06	0.075	0.075
15 - 20	16	16	16	14	12	10	.06	.075	.105	.105
20 - 25	16	16	16	12	10	10	.06	.105	.135	[3]

[1] Pipe with 6-, 8-, and 10-in diameters has 1-1/2 in x ¼-in corrugations.
[2] Riveted or helical fabrication.
[3] Not permitted.

Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drain is to consist of sand, meeting fine concrete aggregate requirements (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100 sieve). If unusual soil conditions exist, a special design analysis shall be made.

The drain shall be a minimum of 2 ft thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 in. beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible

with pipe materials. The antiseep collar(s) shall increase by 15% the seepage path along the pipe.

Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

* To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

- Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 in.

*** Emergency spillways.** Emergency spillways convey large flood flows safely past earth embankments.

An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an emergency spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

*The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 4, less any reduction creditable to conduit discharge and detention storage.

*The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower.

Emergency spillways shall provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 ft, the emergency spillway *shall have a bottom width of not less than 10 ft.

- Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

Structural emergency spillways. If chutes or drops are used for principal spillways or principal emergency or emergency spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook-Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 4, less any reduction creditable to conduit discharge and detention storage.

Visual resource design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

*** Planning criteria for excavated ponds**

*** Design criteria for excavated ponds**

Runoff. Provisions shall be made for a pipe and emergency spillway if necessary. Runoff flow

patterns shall be considered when locating the pit and placing the spoil (see table 4).

Table 4.-Minimum spillway capacity

Drainage area	Effective ht. of dam[1]	Storage	Minimum design storm[2] equency	Minimum duration
acre	*ft*	*ac-ft*	*yr*	*hr*
20 or less	20 or less	less than 50	10	24
20 or less	more than 20	less than 50	25	24
less than 20		less than 50	25	24
All others			50	24

[1] As defined under "Scope."
2 Select rain distribution based on climatological region.

***Side slopes.** Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical.

Perimeter form. If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvillinear.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

* **Excavated material.** The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 ft, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 ft from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment and leveling.
5. Hauled away.

* PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Embankment Pond Specifications

Foundation preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. If needed to establish vegetation, the topsoil and sod shall be stockpiled and spread on the completed dam and spillways. Foundation surfaces shall be sloped no steeper than a ratio of one horizontal to one vertical. The foundation area shall be thoroughly scarified before placement of the fill material. The surface shall have moisture added, or it shall be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

The cutoff trench and any other required excavations shall be dug to the lines and grades shown on the plans or as staked in the field. If they are suitable, excavated materials may be used in the permanent fill. Existing stream channels in the foundation area shall be sloped no steeper than a ratio of one horizontal to one vertical. They shall be deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Foundation areas shall be kept free of standing water when fill is placed on them.

Fill placement

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than 6 in. in diameter (except for rockfills), and other objectionable material.

Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least 1 ft above the adjacent earthfill.

Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading.

Fill material shall be placed and spread beginning at the lowest point of the foundation and then bringing it up in horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers. If openings or sectionalized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than a ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown on the drawings or as staked In the field.

Moisture control

The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met.

Compaction

Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction.

If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain that density.

Fill adjacent to structures, pipe conduits, and drainfill or antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by hand tamping or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

Protection

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, and borrow area if soil and climatic conditions permit. If soil or climatic conditions preclude the use of vegetation and

protection is needed, nonvegetative cover such as mulches or gravel may be used. In some places, temporary vegetation may be used until permanent vegetation can be established. The embankment and spillway shall be fenced if necessary to protect the vegetation.

Preparing the seedbed, seeding, fertilizing, and mulching shall comply with instructions in technical guides.

Principal spillway

Corrugated metal pipe shall conform to the requirements of Federal Specifications WW-P-402 or WW-P-405, as appropriate. Other pipe materials shall conform to appropriate specifications. Antiseep collars shall be of materials compatible with that of the pipe and shall be installed so that they are watertight. The pipe shall be installed according to the manufacturer's instructions. It shall be firmly and uniformly bedded throughout its length and shall be installed to the line and grade shown on the drawings.

Concrete

The mix design and testing of concrete shall be consistent with the size and requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner.

Necessary curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and the forms shall be mortartight and unyielding as the concrete is placed.

Foundation and embankment drains

Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown in the drawings and specifications for the job.

Excavated ponds specifications

The completed excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Embankment and excavated ponds

Construction operations shall be carried out so that erosion and air and water pollution are minimized and held within legal limits. All work shall be con ducted in a skillful and workmanlike manner. The completed job shall present a workmanlike appearance.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Fencing and cover to control erosion and pollution shall be established as needed. Appropriate safety measures, such as warning signs, rescue facilities, and fencing, shall be provided as needed.

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***Reservoir Area**

Borrow removed from the reservoir area should not expose permeable strata. If permeable strata is exposed, the exposed area will be blanketed with impervious material to the following depths:

Water Depth (feet)	Blanket Thickness (feet)
0 - 10	2
10 - 15	3
Over 15	Per Area Engineer

Other methods of treating the exposed area can be referred to Practice Standard 521, Pond Seating or Lining.

***Planning Considerations**

Permits

Prior to design of this practice, procedures as set forth in the NRCS General Manual-450, Part ND481 and ND482, will be reviewed. This establishes the policy for Soil Conservation Service personnel in giving assistance to applicants for water rights, construction permits, or approval of water projects as required by State Law.

Landowners shall be advised that the construction of any pond may require a permit from the U.S. Army Corps of Engineers in accordance with Section 404 of the Clean Water Act. Information and applications may be obtained from the Corps of Engineers Regulatory Office in Bismarck (Tel 255-0015).

Water Quantity

1. Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

2. Variability of the practice's effects caused by seasonal or climatic changes.

3. Effects on downstream flows or aquifers that would affect other water uses.

4. Potential use for water management to conserve water.

Water Quality

1. Effects on the movement of sediment, pathogens, and soluble material substances carried by seepage water.

2. Effects on the visual quality of downstream water resources.

3. Short-term and construction-related effects of this practice on the quality of the pool and downstream water.

4. Effects of soil water level control on the temperatures of downstream waters to prevent undesired effects on aquatic and wildlife communities.

5. Effects on wetlands or water-related wildlife habitats.

Range Planning Requirements

This practice should (1) alter grazing patterns to enhance water quality, protect critical areas, and improve the distribution of grazing, (2) provide reliable water quality and quantity to meet livestock requirements, and (3) be a practical method of providing the needed water.

Normal distribution of watering facilities provides water between 1/4 to 1/2 mile distance in rough terrain, and 1/2 to 1 mile in gentle terrain. For more specific guidelines, refer to Section 803.3, Livestock Water Facilities, National Range Handbook, NRH-1, July 13, 1976, or current publication.

Fishponds

Ponds planned primarily for a sport fishery generally require considerations not needed in other structures.

Ideal sites are those with pond slopes 3:1 or steeper, and no shallow water areas (less than 3 feet).

Where this cannot be met, the side slopes on embankment ponds shall be sloped to a 3:1 ratio or steeper, to a minimum 3 foot depth, for at least 1/2 of the pond shoreline.

For management criteria, see Practice Standard 399, Fishpond Management.

Wildlife Developments - Wildlife developments must provide a suitable environment for the wildlife for which it is to be constructed. For management criteria and site information, see Wildlife Wetland Habitat Management (644) and Wildlife Watering Facility (648) in the Technical Guide.

***Design Criteria for Embankment Ponds**

Soils Investigation - Foundation and borrow investigations shall be completed on all structures before the design is started. The extent of the investigation shall be determined by the person having job approval for the site.

Pond Size - The minimum design size shall be from Table A, Design Criteria for Embankment Ponds. The following items should be considered in determining the required storage for each site:

(1) consumptive use

(2) the net evaporation loss (see Chapter 8, Evaporation - N.D. Hydrology Manual)

(3) seepage loss

(4) annual runoff (see Chapter 7, Annual Yield, N.D. Hydrology Manual)

(5) sediment deposited during the useful life of the structure.

TABLE A

DESIGN CRITERIA FOR EMBANKMENT PONDS

(Table below provides minimum design criteria for drainage area, size, depth, clearing, and spacing)

	Minimum Drainage Area (Ac)	Minimum Average Depth (Ft.)	Minimum Area @Minimum Depth (Sq.Ft.)	Minimum Surface Area (Ac)	Clearing	Spacing
Livestock:						
No water table	30	8	1,000	N.A.	Clear permanent pool area	See narrative for range planning
Reliable inflow (spring)	0	8	1,000	N.A.	"	"
Fire Control	Adequate to provide required storage	-	--	--	--	--
Fishpond:						
Not continuous inflow	100	18	1,000	1.0	Clear permanent pool area	N.A.
Continuous inflow (Min. 20 gal/min)	0	12	1,000	1.0	"	N.A.
Wildlife: 1/						
Brood pond	Adequate to provide required volume & surface area	3	10% of surface area	1.0	N.A.	1/
Satellites	Adequate to provide required volume & surface area	2	--	0.25	N.A.	1/
Watering facility	Adequate to provide required volume & surface area	8	N.A.	N.A.	N.A.	

1/ For details, see Wildlife Wetland Habitat Management(644) and Wildlife Watering Facility (648) Section IV, Technical Guide.

***Seepage Control**

Seepage control measures are to be approved by the State Conservation Engineer.

***Earth Embankment**

Top Width --The minimum top width for dams shall be 10 feet. For heights of 20' or more, Table 1 shall be used.

Side Slopes - The upstream side slope of the settled embankment shall not be steeper than 3:1.

Wave Protection

If the pond has a permanent pool, the upstream slope of the embankment shall be protected according to the following:

Direct Fetch (feet)	Slope Protection
0 - 499	Vegetation.
500 - 1800	Vegetated 10' wide berm at the permanent pool elevation with a minimum 4:1 upstream slope below the berm.
1800+	Refer to Technical Release 56 and 69.

***Principal Spillway**

General - A principal spillway shall be installed when any of the following conditions exist.

1. On drainage areas of 640 acres or more.

2. When springs or other long duration flows exist.

3. When required by State Law.

4. When one or more of the following conditions exist:
   a. The profile of the emergency spillway has any overfall of 2.0 feet or more, less than 150 feet downstream of the control section.

   b. A good vegetative cover can not be established or maintained in the emergency spillway and soils are easily erodible.

   c. The emergency spillway has a potential for livestock traffic. Fencing out emergency spillways should be recommended to eliminate livestock traffic.

Crest Elevations - The crest elevation of the inlet shall not be less than 1.0 feet below the crest of the emergency spillway. Conduits shall be designed to flow full below the crest of the emergency spillway.

Capacity - The minimum principal spillway capacity shall be the 2 yr. - 24 hr. storm or the flow contributed by springs, which ever is larger.

Detention storage may be considered in the design of the principal spillway.

Conduit Size - The conduit diameter shall not be less than 6 inches.

Outlet - When a pipe support is not used, the pipe shall extend not less than 5 feet beyond the point where the downstream slope of the embankment intersects the flow line of the outlet channel. The pipe outlet invert shall be at least one foot above the outlet channel.

A pipe support shall be used for principal spillways 24" or larger. The pipe support shall be placed at the intersection of the downstream slope of the embankment and the flow line of the outlet channel. The cantilever length shall extend a minimum of 5' beyond the pipe support and shall be a minimum of 2.0 feet above the outlet channel.

The minimum length of the outlet section will be 24 feet (without a joint) to provide adequate cover and support strength for the outlet section.

A riprap lined plunge pool or other suitable energy dissipator shall be installed if needed to dissipate energy before the discharge enters the outlet channel.

Principal Spillway Conduit Slopes - The preferred slope of the conduit is 3.0 percent but shall not be less than 1.0 percent. The maximum slope for a hooded inlet of corrugated metal or welded steel pipe shall be 36 percent. When the slope of the conduit exceeds 10 percent on pipe up to and including 18-inch diameter and 7 percent on pipe larger than 18-inch diameter, an elbow will be used 20 feet upstream from the outlet end of the pipe. The slope of the outlet section shall not be more than 6 percent.

Principal spillway barrels should be cambered to assure positive grade in the conduit as foundation consolidation occurs.

Cathodic Protection - Asphalt coating, vinyl coating, or other approved coating on galvanized metal pipe shall be installed in all soils with a saturated soil resistivity less than 4000 ohms-cm or where soil pH is lower than 5.

Cathodic protection should be provided for corrugated steel pipe where the saturated soil resistivity is less than 2500 ohms-cm and shall be provided if less than 1500 ohms-cm.

Seepage Control along Conduits - All conduits, through or under earth embankments, foundations and abutments, shall be protected with anti-seep collars or drainage diaphragms. This includes pipelines, utility lines, trickle tube, etc.

The seepage path used to calculate anti-seep collars shall be the distance from the barrel entrance to the point where the barrel exits the downstream slope. If a foundation or embankment drain is installed, the seepage path is from the barrel entrance to the drain.

The minimum projection of anti-seep collars should be 2 feet beyond the outside diameter of the pipe. The collars should be equally spaced along the portion of the barrel within the saturated zone with the first one approximately 8 feet downstream of the riser.

When the normal cross section of the embankment has been changed for reasons other than stability (roadway, etc.), the number of anti-seep collars may be determined on the basis of a normal embankment template.

Trash Racks - The average flow velocity through the net open area of the trash rack shall not exceed 2.5 fps for all flows.

Standard plans or approved designs will be used.

Reservoir Drawdowns - Reservoir drawdowns shall be installed when required by State Law.

Stock Water Pipe - Consideration should be given to fencing the shoreline and installing a stock water pipeline through the embankment to a stock tank to promote better water quality.

***Emergency Spillways**

Capacity - Criteria for emergency spillway capacity shall be as shown on page 2S.6 in the North Dakota Supplement to the Engineering Field Manual or Table 1-7 of the N.D. Hydrology Manual.

Depth of Flow - The maximum depth of flow used in computing spillway discharge shall not exceed 2.5 feet (Hp).

Velocity - Emergency spillway exit channel velocity shall not exceed those shown below: (velocity can be figured using Manning's equation)

PERMISSIBLE VELOCITIES FOR EMERGENCY SPILLWAYS 1/

Cover 2/	Slope Range (percent)	Permissible Velocity 3/ Erosion Resistant Soils (ft/sec)	Permissible Velocity 3/ Easily Eroded Soils (ft/sec)
Group 1	0-5	7	5
	5-10	6	4
	over 10	5	3
Group 2	0-5	5	4
	5-10	4	3
Group 3	0-5	3.5	2.5
Non-Vegetated	-	3.0	2.0

(continued on page 378-16)

1/ Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained. The values apply to average, uniform stands of each type of cover.

2/ Group 1:
Sod formers used as mixture or as single species:

Creeping foxtail	Intermediate wheatgrass
Pubescent wheatgrass	Smooth bromegrass
Reed canarygrass	Streambank wheatgrass
Thickspike wheatgrass	Western wheatgrass
Big bluestem	Indiangrass
Prairie sandreed	Sand bluestem
Switchgrass	

Group 2:
Mixtures composed of sod formers from Group 1 and bunch grasses from Group 3.

Group 3:
Bunch grasses

Hard fescue	Tall wheatgrass
Green needlegrass	Slender wheatgrass
Blue grama	Little bluestem
Sideoats grama	

3/ Erosion resistant soils are cohesive soils with moderate to high plasticity. Easily eroded soils are cohesionless soils and soils with low plasticity.

Consideration should be given to top soiling, seeding, and fencing all emergency spillways.

Cross Section - Earth and vegetated emergency spillways shall be trapezoidal in cross section and should be located in cut if possible. The minimum bottom width shall be 10 feet regardless of capacity requirements. Unless constructed in rock, the side slopes should not be steeper than 2:1. If snow blockage is a problem, the bottom width shall be increased.

Protective measures to control erosion, such as diversions, shall be used above the side slope to divert foreign water.

Profile - The level section of the emergency spillway shall have a minimum length of 30 feet. The level section shall be straight with the centerline of the exit channel. The control section should be downstream of the centerline of the dam.

The inlet section of the spillway (upstream of the level section) may be curved to fit existing topography and should grade downward to the reservoir area.

The exit channel should be perpendicular to the control section. If curvature is necessary in the downstream exit channel, the curvature shall be far enough downstream so the spillway flow will not endanger the downstream toe of the dam.

A slope greater than critical slope should be provided below the control section.

Wing Dike - A wing dike shall be provided, if needed, to prevent spillway flows from coming in contact with the downstream slope of the dam. The top elevation of the dike along the level section of the spillway shall be the same as the design height of the dam. Below the control section, the top of the dike shall have the same slope as the exit channel and the height shall be equal to or greater than the maximum depth of water in the spillway at peak flood flow. The side slopes of the wing dike shall not be steeper than 2:1 with a minimum top width of 4.0 feet.

Natural Spillway - Natural spillways with grass cover may be used if they are adequate in size, shape, and direct flows away from the embankment. Velocities in the natural spillway shall not exceed the permissible velocity stated in this standard. (See page 3S.51 of the N.D. Supplement to the Engineering Field Manual for capacity.)

EXCAVATED POND

*Planning Criteria for Excavated Ponds

The excavated pond shall be placed in a location that best serves the intended use, considering topography, drainage area, impact on wildlife and habitat, and/or other physical features.

Because of the importance of all wetlands, as set forth in General Manual-190, ND410.26, Protection of Wetlands, excavated ponds shall not be installed in wetlands until alternate sources of water (wells, springs, dams, pipeline, etc.) and/or sites have been considered and it has been determined that there is no practical alternative.

Landowners shall be advised that the construction of any pond may require a permit from the U.S. Army Corps of Engineers in accordance with Section 404 of the Clean Water Act. Information and applications may be obtained from the Corps of Engineers Regulatory Office in Bismarck (Tel. 255-0015).

If an excavated pond is to be placed in or partially in a wetland (Types 2 through 5), the following criteria shall be followed:

Wetlands 1 Acre or Smaller

Excavated ponds shall not be installed in wetlands unless no other suitable site or source of water supply is available. All spoil shall be removed from the wetlands.

Wetlands Over 1 Acre

Excavated ponds may be installed wholly or partially in wetlands. All spoil shall be placed outside the boundary of the shallow marsh (Type 3) or fresh meadow (Type 2)--see Wetland Vegetation Zones--with the following exceptions:

- When abrupt or a rising topography (2 percent or greater) is encountered at a perimeter of the wetland (shallow marsh), the soil may be placed in the wetland. Every effort should be made to place an excavated pond as close to the wetland perimeter as practical to minimize the amount of spoil placed in the wetland.

Placement of Spoil

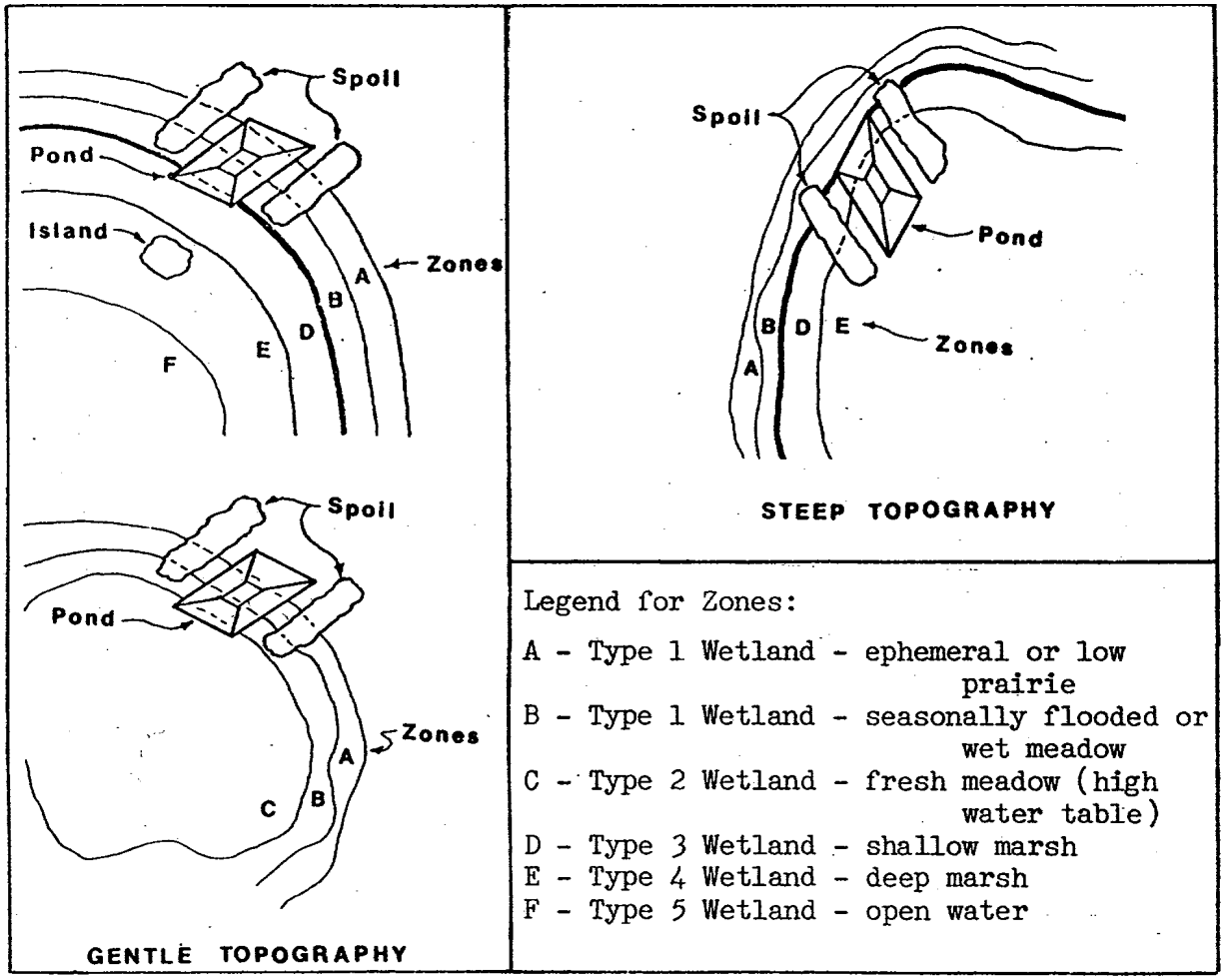
Spoil placed outside a wetland may be leveled. Spoil placed within a wetland shall be piled adjacent to (outside of required berm widths) and on either side of the excavated pond and shall occupy an area approximately equal to the size of the excavated pond. Spoil placed in wetlands shall have a minimum height of 4 feet. The tops of the spoil piles shall be flattened to a minimum width of 6 feet and sloped so that drainage is away from the excavated pond. See exception to placement and flattening under Nesting Islands. Consideration should be given to covering spoil with topsoil and seeding to appropriate mixtures.

Spoil removed from a wetland shall not be used to fill other wetlands.

Special attention shall be given to incorporated features that could improve or maintain wildlife habitat or utilization.

WETLAND VEGETATION ZONES

Pond Development and Spoil Placement



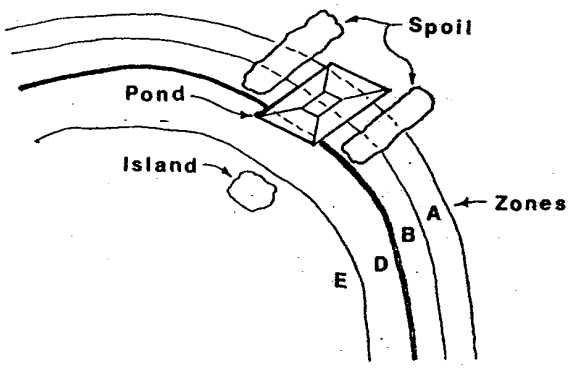
Wildlife Developments

Wildlife developments must provide a suitable environment for the wildlife for which it is to be constructed. For management criteria and site information, see Wildlife Wetland Habitat Management, Practice Standard 644; Wildlife Watering Facility, Practice Standard 648; and Table B, Design Criteria for Excavated Ponds, page 378B-24 of this standard.

Nesting Islands

When approved by the State Biologist, spoil may be used to construct a wildlife nesting island in wetlands Types 3, 4, 5, 10, and 11, over 4 acres is size. They must be located off the excavated pond end opposite the shoreline. Maximum base of the constructed island shall not exceed 50 feet. The top of the island shall be leveled to a height not less than 3 feet, but not to exceed 5 feet. Allow a design height approximately 1.5 feet above the mean water level of the wetland.

Only one nesting island shall be constructed



Vegetation

It is highly desirable to topsoil and vegetate all disturbed areas.

***Design Criteria for Excavated Ponds**

Site Selection - Sufficient soil borings shall be taken to determine if the soil is impervious enough to hold water for surface-fed ponds or to establish the presence of adequate groundwater for groundwater-fed ponds. If the soils are shallow and are underlain by gravel or sand, the seepage rates may be excessive and another site should be selected.

The spacing will be the same as for other livestock, fish and wildlife, or other related uses if more than one excavated pond is required.

Normal distribution of watering facilities provides water between 1/4 to 1/2 mile distance in rough terrain and 1/2 to 1 mile in gentle terrain. For more specific guidelines, refer to Section 803.3, Livestock Watering Facilities, National Range Handbook, NRH-1, July 13, 1976, or current publication.

Capacity and Size Requirements - This practice must (1) improve distribution throughout the pasture, (2) provide reliable water quality and quantity to meet livestock requirements, and (3) be a practical method of providing the needed water.

The minimum design size shall be from Table B, Design Criteria for Excavated Ponds. The following items should be considered in determining the required storage for each site:

(1) consumptive use
(2) the net evaporation loss (see Chapter 8, Evaporation, N.D. Hydrology Manual)
(3) seepage loss
(4) annual runoff (see Chapter 7, Annual Yield, N.D. Hydrology Manual)
(5) sediment deposited during the useful life of the structure.

Consideration should be given to relocating the pond when there is excessive erosion in the drainage area from cropland, etc.

In designing high water table excavated ponds, caution shall be used in selecting minimum depths to insure that an adequate supply of water will be available during seasonal low water levels. Mottled zones in the soil profile indicate fluctuating water tables. Solid colors, usually olive or greenish, occurring below the mottled zone, usually indicate permanent water levels.

TABLE B

DESIGN CRITERIA FOR EXCAVATED PONDS

Principal Use	Minimum 1/ Drainage Area (Acres)	Minimum Average Depth (Feet)	Sq.Ft. @Depth (SqFt)	Minimum Flow (Gal/Min)	Size	Minimum Design Side Slopes	Minimum Design End Slope (with one end Slope 2:1)	Spacing
Livestock:								
No water table	30	8	min. 1000	--	--	2:1	4:1	See narrative for livestock
Reliable water table	0	3' below water table	min. 1000	--	--	2:1	4:1	See narrative for livestock
Fish Pond:								
Not continuous inflow	100	18	min. 1000	--	min.1.0 acre	2:1 but not flatter than 3:1 to depth of 3' below design elev.	That needed for construction	N.A.
Continuous inflow	no min.	12	min. 1000	20	min.1.0 acre			N.A.
Wildlife:								
Brood Pond 1/	Commensurate with size or surface area	3	10% of surface area	--	min.1.0 acre	10:1	10:1	N.A.
Satellites	"	2' not to exceed 3'	--	--	min.900 Sq.Ft. max.6000 Sq.Ft. min. width 30'	6:1*	6:1	At least 150' apart
Level ditching 1/	"	3' not to exceed 4'	--	--	min.2000 Sq.Ft. max.10,000 Sq.Ft. max. 200 ft.long top width 40' to 100'	6:1*	6:1	At least 150' apart max. 1 per 2 ac. marsh
Watering pond	"	8	N.A.	--	max.600 CuYd/Vol.**	2:1	4:1	**
Blasted:	***	***	N.A.	N.A.	min.400 Sq.Ft. max.6000 Sq.Ft. max. 150' long	N.A.	N.A.	At least 150' apart

* Flatter sides may be used if feasible.

** For details, see Wildlife Watering Facility (648) Section IV

*** Refer to narrative Wildlife Wetland Habitat Management (644) Section IV
Site and spoil placement required State office approval.

***Slopes**

When the excavated pond is orientated at the edge of the wetland, the end slopes may be 2:1, if the upland watering ramp is 30 feet wide with a 4:1 slope.

A sand-gravel or scoria blanket should be installed to reduce erosion of the ramp, contamination and bogging down of livestock. A blanket of not less than 6 inches in depth should be recommended on all ramps except gravelly or stable, well drained slopes. The thickness should be increased when boggy conditions exist. The sand-gravel blanket should be reasonably clean pitrun material with approximately 85 percent passing a 1-inch sieve. When scoria is used, the material will be approved by the NRCS representative before placement.

Excavated ponds having unstable or poorly drained slopes should be graveled from the top of the 4:1 slope to 2 feet below average water depth (high water table) or graveled half way down the slope where receiving water from runoff.

If the excavated pond is built in sandy soils, consideration should be given to a 5:1 ramp slope with a gravel or scoria blanket. Consideration should also be given to fencing the other side slopes and along the ramp.

***Excavated Material**

When the excavated material is used in an embankment (dam), provision must be made for safely bypassing floodwater. (See Emergency Spillway Capacity.) The embankment top width and side slopes may be in excess of those required for ponds whenever needed to utilize excess earth from the excavated pond. However, they cannot be less than those required for embankments. When the water depth at the upstream toe of the embankment is 3.0 feet or more, the structure will be designed under criteria for Embankment Ponds.

***Plans and Specifications**

Plans and specifications for embankment and excavated ponds shall give consideration to the installation of:

a. Diversions - above excavated slopes to prevent rilling.

b. Berms or Terraces - to reduce slope lengths on long excavated slopes.

c. Sediment Traps - pits constructed below disturbed areas to trap sediment.

d. Topsoil - embankment, emergency spillway, and other critical areas.

e. Seeding - embankment, emergency spillway, and all disturbed areas.

f. Mulching - critical areas.

g. Fencing - protecting seeded areas.

Required specifications shall appear on the plans or in separate written form, and shall include the following, where applicable:

1. North Dakota Handbook of Construction and Material Specifications for Conservation Practices

   a. Construction Specifications
   b. Material Specifications

2. ND-8, Embankment Pond

3. ND-9, Excavated Pond

As-built plans shall be prepared in accordance with National Engineering Manual, Section 512, Subpart F.